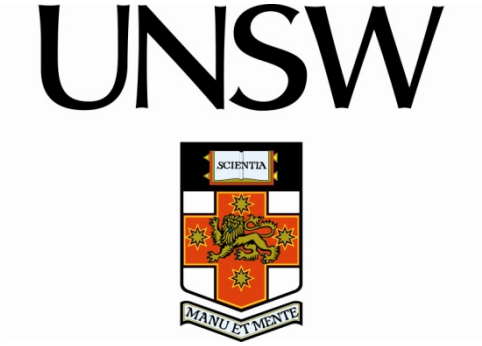

COURSE OUTLINE

School of Photovoltaic and Renewable Energy Engineering

SOLA 5052/9011
Biomass/Biomass Energy Sources

Session 1, 2016

Course Coordinator:
Prof. Evatt Hawkes
Tyree Energy Technologies Building (H6)
Email: evatt.hawkes@unsw.edu.au

Administration/Organization:
Dr. Rob Patterson
r.j.patterson@unsw.edu.au

Contents

1. Executive Summary

What is the course:

- This is an advanced level engineering course about the use of biomass for energy.

Who is teaching it:

- All demonstrators and course staff: **biomass.unsw@gmail.com**
- Lecturer: Dr. Evatt Hawkes (evatt.hawkes@unsw.edu.au)
- Assistant Lecturer: Dr. Robert Patterson (r.j.patterson@unsw.edu.au)

Where/When:

- Students should attend the two-hour lecture each week, and one two-hour tutorial.
- Handbook details: http://www.timetable.unsw.edu.au/2017/SOLA5052.html

Assessment:

- Online Quizzes (weekly X 10, on Moodle), worth 15% of total
- Primer Quiz (week 4), worth 5% of total
- 2 Assignments worth a combined 30% of the total:
    1. *Assignment 1*, 20% - Due end of week 9, Friday @ 5pm
    2. *Assignment 2*, 10% - Due end of week 13, Friday @ 5pm

- 1 Final exam worth 50%
- Attendance not directly assessed. No mid-term.

And now, the LONG version...

2. Staff Contact Details and Methods of Communication

Contact details:

Course email address (used for most inquiries and assignment submission):
biomass.unsw@gmail.com

Assistant Lecturer:
Dr. Rob Patterson
TETB (H6), Rm 210, WS 38
r.j.patterson@unsw.edu.au

Course Co-ordinator:
Dr. Evatt Hawkes
Room: TETB (H6), Rm 129
Phone: 9385 4602
Email: evatt.hawkes@unsw.edu.au

Methods of Communication:

We strongly encourage you to ask any questions you might have about the course ***at the tutorials or lectures***. There is ample time to answer all these questions and more within our allotted 2 hrs per week.

Announcements may be made at lectures or tutorials. If for some reason you do not attend, check with classmates whether any important announcements were made. Otherwise, UNSW Unimail and the Moodle site are the primary methods by which course staff will contact you. ***Be sure to check them daily.***

Email is the preferred method by which you may contact course staff outside of the scheduled teaching times. We use **a course email address*: biomass.unsw@gmail.com*.** This email address is forwarded to / checked by the lecturers and demonstrators, and is therefore your best bet for getting something answered quickly. Your demonstrators are less busy than your lecturers, there are more of them, and they are friendly, so please give them a try in the first instance. However, if you have a question which is not appropriate for a demonstrator – e.g. special consideration – please email the Course Manager or Lecturer directly.

Please always include a subject line that is closely related to the content of your email and ***includes the course-code 5052 or 9011 and the word biomass, and sign with your full name and student number.*** Other consultations are by appointment (made by email).

Moodle will be used to disseminate lecture notes and other references, but email copy of important things will also go out.

3. Course Details

Moodle Website: https://moodle.telt.unsw.edu.au/

Credit Points: 6 units

Summary and Aims of the Course

The course aims to introduce biomass (i.e. material of recent biological origin) as an energy carrier and the technologies associated with its exploitation.

Several sources of raw biomass will be considered including forestry, wastes, energy crops, crop residues, and algae. Methods of production, collection, processing these different sources will be covered. Agriculture and silviculture are largely outside of the scope of the course and are only discussed as a means to estimate biomass production.

Several technologies for the conversion of raw biomass into heat, electricity and fuels will be considered. Specifically the following will be introduced:

• Combustion of raw biomass and biomass-derived liquid and gaseous fuels to produce heat and electricity.

• Thermochemical conversion technologies to produce gas fuels, including pyrolysis and gasification, and to produce liquid fuels such as methanol, biodiesel, or hydrocarbons similar to gasoline (petrol) or Diesel fuels.

• Biochemical conversion options to produce gaseous fuels including anaerobic digestion and to produce liquid fuels including via fermentation.

Student Learning Outcomes

As can be seen in the previous section, a large breadth of topics will be considered. The aim is not to become an expert on all of these topics. Rather, the goal is to obtain a broad understanding of various types of biomass resource and various conversion technologies.

At the same time, in key areas, a basic level of understanding of underlying physical, chemical, and biological processes involved will be taught. This approach will enable both interactions with experts in the area and further learning at greater depth.

At the end of the course, students should:

- Have a broad understanding of different biomass resources (eg, forestry, municipal waste, etc), in terms of their unique characteristics that determine methods of production, collection, processing and options for conversion into higher grade energy products. This understanding will be attained by readings and attending lectures and reinforced through tutorials and assignments.
- Understand and be able to perform simple biomass resource assessments for different types of resources and hence evaluate business opportunities. These outcomes will be developed principally through the tutorials and assignments, in which students will have the opportunity to conduct simple resource assessments.
- Be familiar with and able to assess various options for conversion of biomass into heat, electricity and fuels, and be able to match these with different resources. This understanding will be attained by readings and attending lectures and reinforced through tutorials and assignments.
- Be able to apply the fundamental governing and operating principles of key conversion options, in enough depth to be able to perform idealised calculations and derivations relating to these principles. The governing and operating principles will be learned via lectures and readings, while ability to perform relevant calculations will be developed through tutorials and assignments.

Assumed Knowledge

Students should have a good working knowledge of university level physics, mathematics, chemistry, and thermodynamics. There is a strong component of ***engineering calculations*** involving dimensional reasoning and balances of mass and energy.

Graduate Attributes

This course will assist students in their development of the following UNSW graduate attributes (as listed at https://my.unsw.edu.au/student/atoz/GraduateAttributes.html):

1. Understanding their discipline in its interdisciplinary context;
2. Rigorous in their analysis, critique, and reflection;
3. Able to apply their knowledge and skills to solving problems;
4. Capable of effective communication;
5. Information literate;
6. Capable of environmental responsibility.

Developed Competencies

The Engineers Australia policy on Accreditation of Professional Engineering programs requires that all programs ensure that their engineering graduates develop Stage 1 elements of competency (see: http://www.engineersaustralia.org.au/membership/assessment). Listed below are the activities in this course that will help students to achieve at least some of these elements of competency. Note: that not all elements of competency are relevant to each course.

Professional Engineering Stage 1 Elements of Competencies	Activities used to Develop Competency
Knowledge Base	
PE1.1 Comprehensive, theory based understanding of the underpinning natural and physical sciences and the engineering fundamentals applicable to the engineering discipline.	Lectures, tutorials, and assignments incorporating fundamental knowledge of mass and energy balances, and the second-law of thermodynamics. Lectures giving fundamental description of processes involved in biomass conversion (eg combustion, gasification, anaerobic digestion).
PE1.2 Conceptual understanding of the mathematics, numerical analysis, statistics, and computer and information sciences which underpin the engineering discipline.	Lectures, tutorials and assignments developing competence in assessments of biomass resources, conversion technologies, and economics.
PE1.3 In-depth understanding of specialist bodies of knowledge within the engineering discipline	Via twelve weeks of two-hour tutorials, and three comprehensive assignments, extensive development of students ability to perform relevant calculations involving biomass energy systems – principally involving detailed mass and energy balances, and basic-level economics.
Engineering Ability	
PE2.1 Application of established engineering methods to complex engineering problem solving.	Tutorials and assignments are designed to promote ability to *independently* solve problems. Problem identification is not strongly emphasized in the course; the focus is mainly on formulation and solution. First-principles based reasoning is developed to solve problems as opposed to a traditional formulaic approach in which students recognize “this is problem type X, therefore I know

	to apply formula Y".
PE2.2 Fluent application of engineering techniques, tools and resources.	Lectures/ tutorial discussions, and discussion questions in assignments develop the students appreciation of the complexity of the environmental issues associated with bioenergy – namely the positive aspects such as reduced carbon emissions versus negatives associated with additional large-scale agricultural production of biofuels.
PE2.3 Application of systematic engineering synthesis and design processes.	Assignment 1 develops systems-based thinking by considering a detailed economic assessment of a short-rotation forestry operation. Assignment 3 is based on a site-visit to an anaerobic digestion facility and several questions focus on appreciation of the systems aspects of the facility.
PE2.4 Application of systematic approaches to the conduct and management of engineering projects.	Not directly developed.
Professional Attributes	
PE3.2 Effective oral and written communication in professional and lay domains.	Preparing written assignments, interacting with demonstrators in tutorials.
PE3.4 Professional use and management of information.	Tutorial and assignment tasks requiring effective representation of data.
PE3.5 Orderly management of self, and professional conduct	Not directly developed.

4. Rationale for the Inclusion of Content and Teaching Approach

The content has been selected to provide a broad coverage of the status and prospects for bioenergy. This will enable effective interactions with experts in the various sub-disciplines involved and will assist high level decision making in the renewable energy area. The teaching approach as outlined below is designed to give both breadth of knowledge through lectures and depth of knowledge in some key topics through tutorials, which also develop crucial skills in problem solving generally. The theoretical material is complemented by invited lectures from industry who describe the business realities of bioenergy projects, with reference to real case studies in their organizations.

5. Teaching Strategies

Lectures will be used to introduce the factual information, theory, and methods of the course. Learning during lectures should be later reinforced by reading reference materials and working through the assignments.

Tutorials will be used to demonstrate how to apply the facts, theory and methods delivered in lectures to idealised problems, to work on assignments and exam practice questions, and for discussion of key points with demonstrators and/or lecturer.

Assignments then further develop (by calculation, critical analysis and discussion) and assess student learning by application to more complex and involved problems.

The final exam assesses student learning as a result of the course. Sorry about that.

6. Assessment

The overall course mark is comprised of 20% for quizzes, 30% for assignments and 50% for a final exam.

Attendance

I do not mark attendance at tutorials or the lectures; however I strongly advise it in order to pass the course. I do give additional information in the lectures and tutorials that is not posted online. Tutorials will be particularly useful because the demonstrators will guide you through a process of problem solving, which will be very helpful in the final exam.

Assignments

Assignment 1 due @ 5pm, Friday, end of week 9 (worth 20%)

Assignment 2 due @ 5pm, Friday, end of week 13 (worth 10%)

The assignment topics are, respectively:

1) Equilibrium products of biomass gasification (chemical thermodynamics)
2) Anaerobic digestion, pyrolysis, biomass co-firing (questions from guest speakers)

Submission of assignments: The return date of each assignment is shown on the first page of the assignment question sheet. If it differs from the above, take the date on the assignment or clarify with a demonstrator. Submission instructions will also be given for each assignment. Electronic submission (by e-mail) is required to save cellulosic biomass!

Late assignments will be penalized 30% plus 10% per day that the work is late (i.e. 40% if one day late), to a maximum penalty of 100%, except in highly exceptional and verifiable cases.

Quizzes

1) A 'Primer Quiz', worth 5% of the course mark will be given in the week 4 tutorial. This quiz will cover dimensional reasoning, thermodynamics, and the basics of solving Biomass questions.
2) Weekly quizzes (10) will be posted on Moodle just after the weekly lecture and will be due (e.g. set to close) just before the start of the next lecture.

Important: No late quizzes will be accepted!

Final Exam

The exam will consist of written short answer questions, calculations and derivations. About half of the marks will be available for short answer written questions that mainly assess the breadth of your knowledge, while the other half will include more involved calculations that assess depth. All material presented in the course (including via Moodle) is examinable unless otherwise explicitly stated.

If you are ill on the day of the final exam, inform course staff immediately and bring a doctor's certificate.

Scaling

If necessary, overall marks or marks from individual assessments may be scaled. The average mark is expected to be in the range 64-74.

Parallel Teaching

The Undergraduate and Postgraduate versions of this course are identical. Undergraduate and Postgraduate students will attend the same lectures and tutorials.

Lecture Times and Locations
This course comprises three-four hours of formal contact per week. The timing and rooms are given below.

Lectures	Location:	Chemical Sci M11 (K-F10-M11)
Time:	Wednesday	13:00 - 15:00
	(Lectures go for about 50 min, break for 10, then another 50 min.)	

Tutorials (following week 2 lecture)	Location:	Blockhouse G6 (K-G6-G6)
	Time:	Mon 16:00 - 18:00
	or	
	Location:	Blockhouse G16 (K-G6-G16)
	Time:	Tues 16:00 - 18:00

7. *Resources for Students*

- **Moodle Site:** All handout materials, including lecture notes, tutorials and assignments, and additional optional readings, will be distributed via the official site for this course, at **https://moodle.telt.unsw.edu.au/**. Notes for each lecture will be posted prior to the lecture, or shortly afterwards.
- **Optional Textbook:** Ralph Sims, The Brilliance of Bioenergy in Business and in Practice (James & James, London, 2002, 314 pages, ISBN 1 902916 28 X). It is quite expensive and not perfect, and is therefore optional. The UNSW Library has several copies; the book is also available from the UNSW Bookshop, and through online bookstores. It should be possible to pass the course without owning a copy of the textbook, however it is helpful.
- **Library:** students seeking resources can also obtain assistance from the UNSW Library. One starting point for assistance is: http://www.library.unsw.edu.au/servicesfor/students.html.

8. Course Evaluation and Development

This course was completely redeveloped in 2008 and is still in a process of continual improvement. At the end of the course, you will be asked to complete two evaluation forms – one for the course and one for the course coordinator using the UNSW's Course and Teaching Evaluation and Improvement (CATEI) Process. Your feedback is much appreciated and taken very seriously. Continual improvements are made to the course based in part on such feedback and this helps us to improve the course for future students.

Otherwise please don't hesitate to come and chat at the end of a lecture or with your demonstrators about any (hopefully constructive) suggestions.

9. Student Responsibilities and Class Policies

1. **Late assignments** will be penalized 30% plus 10% per day that the work is late (i.e. 40% if one day late), to a maximum penalty of 100%, except in highly exceptional and verifiable cases. **Important: No late quizzes will be accepted!**

2. **Attendance and Attention**. Responsibility for earning marks rests solely with the student. It is advised to attend lectures, to avail yourself of the subject resources, to complete your assignments

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and quizzes on time and to the best of your ability, participate in the tutes, and to be fully aware of the course syllabus, including any announcements or changes to that syllabus.

3. **Plagiarism.** All assignments and tutorials are for individual effort and individual assessment only, with a few exceptions that will be clearly noted. You are expected to be aware of, and you will be subject to, the UNSW and School policies that cover plagiarism of written work. Students *will* be penalised for plagiarism in tutorial, assignment and exam work. See below.

10. What is Plagiarism?

Plagiarism is the presentation of the thoughts or work of another as one's own.* Examples include:

direct duplication of the thoughts or work of another, including by copying material, ideas or concepts from a book, article, report or other written document (whether published or unpublished), composition, artwork, design, drawing, circuitry, computer program or software, web site, Internet, other electronic resource, or another person's assignment without appropriate acknowledgement;

- paraphrasing another person's work with very minor changes keeping the meaning, form and/or progression of ideas of the original;
- piecing together sections of the work of others into a new whole;
- presenting an assessment item as independent work when it has been produced in whole or part in collusion with other people, for example, another student or a demonstrator; and
- claiming credit for a proportion a work contributed to a group assessment item that is greater than that actually contributed.†

For the purposes of this policy, submitting an assessment item that has already been submitted for academic credit elsewhere may be considered plagiarism.

Knowingly permitting your work to be copied by another student may also be considered to be plagiarism.

Note that an assessment item produced in oral, not written, form, or involving live presentation, may similarly contain plagiarised material.

The inclusion of the thoughts or work of another with attribution appropriate to the academic discipline does *not* amount to plagiarism.

The Learning Centre website is main repository for resources for staff and students on plagiarism and academic honesty. These resources can be located via:
www.lc.unsw.edu.au/plagiarism

The Learning Centre also provides substantial educational written materials, workshops, and tutorials to aid students, for example, in:
- correct referencing practices;
- paraphrasing, summarising, essay writing, and time management;
- appropriate use of, and attribution for, a range of materials including text, images, formulae and concepts.

Individual assistance is available on request from The Learning Centre.

Students are also reminded that careful time management is an important part of study and one of the identified causes of plagiarism is poor time management. Students should allow sufficient time for research, drafting, and the proper referencing of sources in preparing all assessment items.

* Based on that proposed to the University of Newcastle by the St James Ethics Centre. Used with kind permission from the University of Newcastle

† Adapted with kind permission from the University of Melbourne.

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11. Other Information

Special Consideration for Illness or Misadventure

If you are unable to submit a piece of assessment on time, or to participate fully in laboratory sessions, due to illness or some other event which was beyond your control, you must follow the central UNSW procedures for seeking special consideration. Details of these can be found at https://student.unsw.edu.au/special-consideration.

Please be aware that requests for special consideration need to be submitted to UNSW Student Central as soon as is practicable after the problem occurs and within three working days of the due date of the relevant assessment task.

Disability Support

Those students who have a disability that requires some adjustment in their teaching or learning environment are encouraged to discuss their study needs with the course coordinator prior to, or at the commencement of, their course, with the Equity and Disability Officer in the school office (9385 7993) or with the Equity Officer (Disability) in the Equity and Disability Unit (EADU) 9385 4734. Issues to be discussed may include access to materials, signers or note-takers, the provision of services and additional exam and assessment arrangements. Early notification is essential to enable any necessary adjustments to be made.

Further information for students with disabilities is available at:
http://www.studentequity.unsw.edu.au/

12. Course Schedule.

(See next page. Note: Modifications are possible to suit the availability of guest speakers.)

Week	DATE	Lecture Syllabus (tentative, subject to change)	*Tutorial Syllabus*	Assessment Syllabus
1	1/3	Course Introduction	No Tutorial	
2	8/3	The Biomass Resource	Resource assessment.	
3	15/3	Supply chain	Resource assessment.	
4	22/3	Thermochemical conversion fundamentals: thermochemical systems, mass and energy balances	Supply chain.	Primer Quiz
5	29/3	Guest lecture: Steven Schuck, Manager Bioenergy Australia (Australia's peak body in the bioenergy arena): Status and prospects for bioenergy in Australia and internationally.	More resource assessment and basics of thermochemical systems.	
6	5/4	Guest lecture: Tony Esplin, Director, RecyclingTechGroup: real industry experience in Australia doing Biomass/Bioenergy work	Combustion, adiabatic flame temperatures.	Assignment 1 given out.
7	12/4	Thermochemical conversion fundamentals: equilibrium, gas turbines	Work on Assignment 1	
	15/4-23/4	MID-SESSION BREAK	MID-SESSION BREAK	
8	26/4	Thermochemical conversion applications: combustion of dry solid fuels; basics of steam turbine power cycles	Gas turbine and IC engine cycle analysis. Work on Assignment 1	
9	3/5	Thermochemical conversion applications: gasification and pyrolysis	Chemical equilibrium: combustion Work on Assignment 1.	Assignment 1 due (Fri., 5pm)
10	2/5	Biochemical gasification	Biochemical gasification Work on Assignment 2.	Assignment 2 given out
11	10/5	Guest lecture by Earthpower. Site visit: Earthpower, anaerobic digestion facility (outside lecture time, TBD).	No tutorial (site visit instead)	
12	17/5	Conversion to liquid fuels by biochemical or thermo-chemical means.	Chemical equilibrium: gasification.	
13	24/5	Exam Prep, No lecture	Exam revisions (if required)	Assignment 2 due